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Final Evaluation of the City of Houston (Texas) Department of Health's Programs to Regulate Air Pollution from Stationary Sources

Booz-Allen and Hamilton, Inc.
Bethesda, MD

Prepared for

Council on Environmental Quality
Washington, DC

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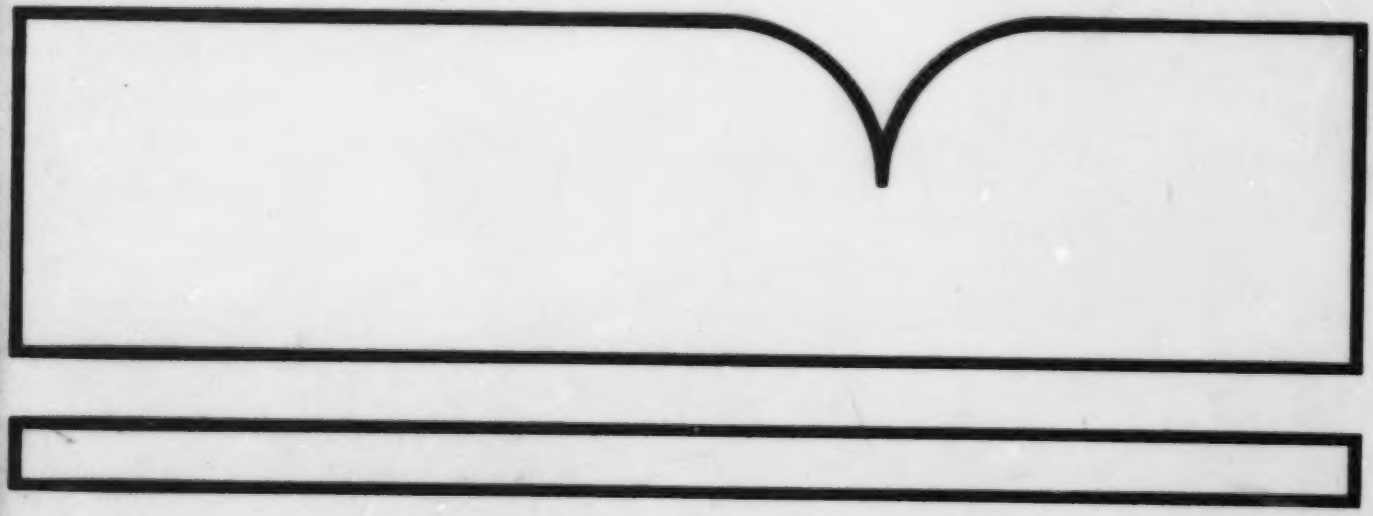

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CEQ and EPA sponsored five studies examining the response of sources to the regulatory approach to controlling air pollution, with emphasis on the post-compliance emissions history. The study areas are: North Carolina (3 vols), Houston (3 vols), San Diego (3 vols), Chicago (3 vols), and New Jersey (2 vols).

In order to evaluate Houston's effectiveness in promoting both initial and continuing compliance, this report integrates the findings from the Task I review and the Task II examination of emissions performance at 20 stationary sources. Based on the findings, it recommends changes to the programs which will strengthen their effectiveness, particularly in the promotion of continuing compliance.

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FINAL REPORT: TASK III

Final Evaluation of the City of Houston (Texas) Department of Health's Programs to Regulate Air Pollution From Stationary Sources

JULY 1, 1979

PREPARED FOR

PRESIDENT'S COUNCIL ON ENVIRONMENTAL QUALITY

OFFICE OF PLANNING AND EVALUATION
U.S. ENVIRONMENTAL PROTECTION AGENCY

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June 27, 1979

Mr. James S. Vickery
Office of Planning and Evaluation
Room 1019-B (West Tower)
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Jim:

We are pleased to submit our final Task III report entitled "Final Evaluation of Houston (Texas) Department of Health's Programs to Regulate Air Pollution From Stationary Sources." Key contributors to the report were Barry Russell of Booz, Allen, and Herb Belknap and Jerry Isaacs of PEDCo Environmental Inc.

This report summarizes our findings on source performance developed during the case studies conducted in Task II. It also integrates these findings with our preliminary findings on agency performance from Task I and presents an assessment of the Houston Department of Health's major strengths and weaknesses in promoting initial and continuing compliance among stationary sources. Where we have identified weaknesses, we have recommended specific program adjustments. Finally, we have presented a discussion of several economic incentive measures which could be used to supplement or replace the current direct regulation approach.

While we feel that this report contributes some interesting and useful insights on the success of the direct regulation approach, two constraints prevented us from making our findings and recommendations as definitive and comprehensive as we had hoped. First, as we have discussed with you throughout the project, data on agency programs and source emissions was not as extensive as we had hoped and therefore did not provide a definitive picture of agency activities and source responses. Second, we had fewer resources than anticipated with which to conduct the Task III integration of findings. At your request, we had reallocated some of the resources earmarked for Task III to the collection of additional agency performance data for Task I. Consequently, we were unable to conduct as thorough a review of economic incentive alternatives as initially anticipated.

We hope you find this report useful, and we will be available to answer any questions on it which you may have.

Sincerely,

Alan L. Farkas

BOOZ . ALLEN & HAMILTON Inc.

Alan L. Farkas
Principal

I. EXECUTIVE SUMMARY

The purpose of this report is twofold. First, in order to evaluate Houston's effectiveness in promoting both initial and continuing compliance, it integrates the findings from our Task I review of the Houston Department of Health's (DOH) air quality programs and the Task II examination of the emissions performance of 20 stationary sources. Second, based on the integrated findings, it recommends changes to the programs which will strengthen their effectiveness, particularly in the promotion of continuing compliance. Changes discussed include both program adjustments within the existing regulatory framework as well as economic incentive alternatives to direct regulation.

The findings and recommendations are presented in the following three chapters:

- Source Performance
- Program Effectiveness
- Program Modifications.

The first of these chapters briefly discusses the excess emissions problem in Houston, Texas. The second chapter presents the principal findings on agency strengths and weaknesses and identifies some needed adjustments to current programs within the existing direct regulation approach to stationary source control. The final chapter describes some alternative approaches and their potential applicability to the particular situation in Houston. Source and agency costs of control are presented in Appendices A and B of the report.

1. SOURCE PERFORMANCE

This chapter briefly summarizes the findings from our examination in Task II of the compliance status of 20 sources in ten industrial categories. These findings are as follows:

- Excess Emissions by Industrial Category. The 20 sources examined in Task II cover ten industrial categories. All categories, except asphalt plants, experienced excess emission events. The grain handling, refinery and fertilizer industry categories showed the most incidence of excess emissions events, but the refinery category had the most events of the longest duration.

- Excess Emissions by Control Equipment Category

  The 20 sources examined in Task II contain six types of pollution control equipment. Of these categories, electrostatic precipitators have the greatest frequency of excess emission episodes both in the short term between 1 and 24 hour periods and long term lasting between 1 and 12 months. Cyclones have the greatest amount in volume of excess emissions.

- Causes of Excess Emissions. We found that poor design efficiency was the most frequent cause of excess emissions. It was the primary cause of excess emissions in 6 sources and the contributing cause in 7 sources.

2. AGENCY EFFECTIVENESS

This chapter integrates the findings from the review of agency programs and the examination of 20 sources conducted during Task I and Task II. For three major program elements currently administered by the Houston Department of Health, it identifies principal strengths and weaknesses. Where weaknesses are identified, the chapter recommends possible corrective actions. The role of the state is also discussed since in many instances the state has provided or continues to provide significant support in the administration of the programs.

We found that air pollution requirements and programs have been effective in reducing emissions and maintaining continuing compliance for the majority of stationary sources in the Houston area. All of the sources we examined have installed air pollution control equipment in response to mandated regulations and agency programs. Most of these sources have exhibited good compliance records and many have reduced their emissions considerably below required levels. However, we also found that the use of sanctions to bring some sources into continuing compliance has been ineffective. It appears that a more aggressive enforcement program would improve the compliance status of these sources.

(1) The Permit Program

In Texas, new and modified sources are required to install Best Available Control Technology (BACT). This requirement is imposed on sources by permit both during the construction and operation of the facility. The

Houston Department of Health (DOH) and the Texas Air Control Board (TACB) are active in reviewing the proposed permits. We found the permit requirements and the review process effective in reducing source emissions on a continuing basis.

(2) The Surveillance Program

The Houston Department of Health Surveillance Program includes an annual inspection, complaint investigations, investigation of upset problems, and 24-hour visual surveillance by automobile. We found that these elements were effective in detecting violations and that the constancy of surveillance creates an agency presence which encourages compliance. However, we also found the agency weaker at documenting violations after detection and in surveillance activities related to invisible pollutants such as sulfur oxides and hydrocarbons. We recommend increased use of stack tests, opacity, and property ambient measurements to better document violations. In addition, we recommend greater use of property line ambient measurements for surveillance of both hydrocarbons and sulfur oxides.

(3) The Enforcement Program

Our evaluation of the enforcement program focuses on the present postcompliance efforts of the Houston Department of Health. We found that while the voluntary compliance program currently administered may be effective in promoting compliance among sources which need little incentive to comply, it is unsuccessful in using sanctions against more recalcitrant sources to promote compliance. We recommend a more aggressive enforcement program consisting of more administrative conferences, more civil and criminal prosecutions, seeking greater fines, and enforcement actions against sources with upset and maintenance problems which result in chronic violations.

3. ECONOMIC INCENTIVES

The final chapter of the report discusses the following four categories of incentives:

- Financing incentives
- Pricing incentives

- Hybrid permit systems
- Promotion of nonpolluting goods.

We describe several options within each category and their possible applicability to the excess emissions situation and specific program weaknesses in Houston. In many cases, our analysis shows, the specific technical and management problems found in current programs probably would not be resolved or eliminated by an economic incentives approach. We recommend, therefore, additional investigation to document convincingly the appropriateness of economic incentives.

II. SOURCE PERFORMANCE

This chapter briefly summarizes the findings from our examination in Task II of the compliance status of 20 of Houston's major sources. Detailed analyses for each of the 20 sources are in the Task II final report. This summary presents the following four categories of information:

- Emissions estimates for each source
- Estimate of levels, frequency, and duration of excess emissions by industrial category
- Estimates of levels, frequency, and duration of excess emissions by pollution control system category
- Causes of postcompliance excess emissions.

Capital and O&M costs incurred by each source, related to emissions reductions, are presented in Appendix A.

1. SUMMARY OF EMISSIONS ESTIMATES

Based on available data and external and internal inspections of the control equipment, we attempted to identify the amount of excess emissions for each of the 20 sources examined. The results of the emissions estimates for each source are displayed in Exhibit II-1 on the following page. This exhibit shows the values of potential uncontrolled emissions and allowable emissions. With these values as a context with which to evaluate actual performance, the exhibit summarizes excess emissions. It also shows "emission credits," that is, the extent to which actual emissions were below the allowable emission. It is evident from the exhibit that there are many more emission credits than excess emissions. There are 14 sources with emission credits higher than excess emissions. There are 9 sources with ten times more emission credits than excesses and 4 sources with fifty times more credits than excesses.

EXHIBIT II-1
Summary of Emissions Estimates

Control Equipment			Emissions (Annual Average x Age), Tons				
Source No.	Type	Age	Uncontrolled Emissions	Allowable Emissions % Reduction	Allowable Emissions Tons	Emission Credits	Excess Emissions
21	ESP	4	67,200	96*	2772	2052	0
22	Scrubber	3	2,100	-	-	-	-
23	Cyclone	1	1,728	87*	216	0	252
24	ESP	8	10,368	55	4631	2298	417
25	ESP	3	2,484	56	1090	972	0
26	Scrubber	8	17,280	66	5806	466	300
27	SCOT**	2	3,960	80*	792	418	86
28	ESP	7	41,580	89	4684	2420	658
29	ESP	8	6,336	40	3801	1612	752
30	Scrubber	3	1,500	-	-	-	-
31	Fabric Filter	5	2,000	-	-	-	-
32	Mist Eliminator	3	2,268	65	786	600	8
33	Fabric Filter	4	49,920	98	811	225	125
34	Fabric Filter	2	43,200	92	3447	2524	60
35	HC Incinerator	1	8,640	75	2160	2800	36
36	Fabric Filter	6	16,200	83	2700	2100	132
37	Fabric Filters	3	-	-	-	-	-
38	Scrubber	3	17,640	90	1693	1292	100
39	Scrubber	7	3,628	58	1512	720	50
40	Scrubber	8	1,600	96	56	0	400

* New Source
** Shell Claus Off-gas Treater

2. PERFORMANCE BY INDUSTRIAL CATEGORY

In Exhibit II-2 we integrate the data on excess emissions according to industrial category. For 10 source categories, the table shows the estimated number of emissions events in each of 4 categories of duration. The exhibit also shows the estimated excess emissions as a percent of allowable emissions. According to the exhibit, the surface coating industry averaged annual emissions in excess of 400 percent of allowable emissions. In addition, the surface coating industry shows the largest total number of excess emissions events lasting longer than 12 months and between 1 and 12 months. The exhibit also shows that refineries have the greatest number of excess emission events between 1 and 24 hours that produce the most excess emissions. It is important to remember, however, that since the most number of sources in any of the 10 categories studied was 4, extrapolation of these findings to the entire city of Houston would be tenuous. Finally, the exhibit shows the types of data which form the basis for the estimates.

3. PERFORMANCE BY CONTROL EQUIPMENT CATEGORY

Exhibit II-3 displays the level, frequency, and duration of excess emissions for five types of pollution control devices:

- Electrostatic precipitators (5)
- Fabric filters (3)
- Cyclone (1)
- Scrubbers (4)
- Claus off-gas treater (1)
- Hydrocarbon incinerators (1).

As in Exhibit II-2, the indicators used to develop estimates of excess emissions are shown. The table shows that the electrostatic precipitators have the greatest frequency of excess emission episodes lasting between 1 and 12 months and the greatest frequency of episodes lasting between 1 to 24 hours. It also shows that cyclones have the greatest amounts of excess emissions in volume.

4. CAUSES OF EXCESS EMISSION

Exhibit II-4 displays the following eight causes of excess emissions:

- Poor design efficiency
- Improper maintenance

EXHIBIT II-2
Excess Emissions for Categories of Sources Studied in Houston, Texas

Source	Combined Years	Estimated Number and Duration of Excess Emission Events				Estimated Excess Emissions		Emission Indicators (See Notes)
		1-12 months	1-4 weeks	1-7 days	1-24 hours[1]	Tons/yr	% Allowable	
Pulpmill (1)								
Recovery Boilers	4	0	0	0	0	0	0	2,3,5,6
Thermal Oxidation	3	0	1	2	36	(a)	(a)	2,3,5,6
Refineries (4)	20	2	9	20	800	48.5	32.5	2,4,5,6
Refineries (1)								
Off-gas Treater	2	0	3	0	0	43	10	2,4,5,6
Cement Plants (2)	15	(a)	(a)	(a)	(a)	94	17	2,5,6
Asphalt Plants (2)	8	(a)	(a)	(a)	(a)	(a)	(a)	
Mineral Acid (1)	3	0	0	3	33	2.7	1	2,5,6
Iron and Steel (2)	6	0	4	12	154	26	2	2,4,5,6
Petrochemical (1)	1	0	0	0	14	36	2	4,5,6
Grain Handling (1)	6	0	0	12	972	22	5	2,4,6
Fertilizer (2)	10	0	0	10	380	15	5	2,4,5,6
Surface Coating (1)	8	8	0	0	0	50	400	2,4,5,6

(a) Unknown.

1. The number of excursions above allowable emission rates for one hour or less cannot be estimated in most cases.
2. Opacity records.
3. Malfunction reports.
4. Operating logs.
5. Stack tests.
6. Engineering judgement.

EXHIBIT II-3
Excess Emissions for Categories of Control Devices Studied in Houston, Texas

Control Device Type	Combined Years	Estimated Number and Duration of Excess Emission Events				Estimated Excess Emissions		Emission Indicators (See Notes)
		1-12 months	1-4 weeks	1-7 days	1-24 hours[1]	Tons/yr	% Allowable	
ESP (5)	30	8	8	76	1750	45	8.5	2,4,5,6
Fabric Filters (3)	12	0	4	13	262	23	6	2,4,5,6
Scrubbers (4)	21	0	3	7	813	20	4	2,4,5,6
Claus Off-gas treater (1)	2	0	3	0	0	43	10	2,4,5,6
Hydrocarbon Incinerator (1)	1	0	0	0	14	36	2	4,5,6
Cyclone (a) (1)	1	1	0	0	0	252	116	2,5,6

(a) This poor performance is due to inadequate process design.

1. The number of excursions above allowable emission rates for one hour or less cannot be estimated in most cases.
2. Opacity records.
3. Malfunction reports.
4. Operating logs.
5. Stack tests.
6. Engineering judgement.

EXHIBIT II-4
Summary of Excess Emission Causes

Causes	Primary cause no. of sources	Contributing cause no. of sources
Poor design efficiency	6	7
Improper maintenance	2	5
Lack of spare parts	0	4
Routine component failure (not preventable)	3	7
Improper materials of construction	0	2
Improper operation	0	4
Process upsets	5	3
Lack of instrumentation	0	1

- Lack of spare parts
- Routine component failure (not preventable)
- Improper materials of construction
- Improper operation
- Process upsets
- Lack of instrumentation.

According to the exhibit, poor design efficiency was the single largest primary cause of excess emissions. In addition, poor design efficiency and routine component failure were the single most important contributing causes of excess emissions. Again, it is necessary to remember that the small size and questionable quality of some of the data precludes the generalization of these findings to all major sources in Houston.

III. EFFECTIVENESS OF AGENCY PROGRAMS

This chapter presents our evaluation of the effectiveness of air pollution control regulation in Houston, Texas. It is based on a preliminary evaluation of agency programs presented in Task I of this study and an assessment of source compliance presented in Task II.

Generally, we found that air pollution requirements and programs have been effective in reducing emissions and maintaining continuing compliance for the majority of stationary sources in the Houston area. All of the sources we examined have installed air pollution control equipment in response to mandated regulations and agency programs. Most of these sources have exhibited good compliance records and many have reduced their emissions considerably below required levels. However, we also found that actions to bring several sources into continuing compliance have been ineffective. It appears that a more aggressive enforcement program would improve the compliance status of these sources.

This chapter is divided into three parts which correspond to the major program areas of the Houston Department of Health:

- The Permit Program
- The Surveillance Program
- The Enforcement Program.

Each program is briefly summarized, and followed by our major findings and recommendations.

1. THE PERMIT PROGRAM

Permit programs are crucial to successful regulation of stationary sources since they offer agencies an opportunity to review and influence the sources' proposed strategies for complying with applicable standards. By permit, agencies can encourage sources to adopt well designed, adequately sized control equipment that is constructed with the proper materials. In Texas, new and modified sources are required to install Best Available Control Technology (BACT). This requirement is imposed on sources by permit both during the construction and operation of the facility. The Houston Department of Health (DOH) and the Texas Air Control Board

(TACB) are active in reviewing the proposed permit. Generally, we found the permit requirements and the review process effective in reducing source emissions on a continuing basis.

(1) Stringent Requirements and a Thorough Review Process Appear Effective

Air pollution control in Houston has benefitted from the early establishment of stringent requirements for new sources by the TACB. Using the permit process, Texas has required Best Available Control Technology (BACT) on all new and modified facilities since 1973. This requirement is especially significant in Houston because of the rapid growth of industry over the last five years. Also, emission limitations have been added as a requirement in the last year. An emission limitation is important because even with the installation of proper control equipment, an enforceable limitation places the risk of equipment effectiveness or malfunction with the source.

Both the Houston DOH and the regional office of the TACB perform engineering evaluations of the data submitted with the permit applications. The data required to be submitted with the construction and operating permits appears extensive. It includes:

- Location of the units
- Operating schedule
- Unit classification (new or used)
- Complete process description
- List of emission sources including flow rates, stack heights, temperature and velocity
- Characteristics of input (fuel, waste material)
- Characteristics of output (flue gas)
- Control equipment (type, efficiency, and drawings).

A joint inspection is conducted by the regional office of the Texas Air Control Board and the Houston Department of Health to verify information submitted by the source, and to determine whether the proposed

location may constitute a nuisance. After a source begins operation, the TACB and the DOH review stack test information, property line samples and process parameters to determine compliance. The recommendations from this joint inspection are sent to the TACB in Austin to verify that emission rates are consistent with the National Ambient Air Quality Standards (NAAQS).

Our evaluation of the permit program is based almost entirely on information provided in Task I of the study. Although Task II provided little information upon which to change or modify our preliminary findings, an apparent failure of the permit program was discussed. Of the 20 sources chosen for Task II, 5 sources were new or modified sources subject to permit requirements. Of these sources, one did not install BACT but rather equipment of a new design which failed to perform according to design specifications. As a result, the source is out of compliance 100 percent of the time with the emission limitations required by the operating permit, although the source is in compliance with emission limitations for existing sources. The remaining 4 sources have maintained compliance.

(2) Duplication of Permit Review May Be Inefficient

An overlap in responsibility occurs between the TACB and the Department of Health in the administration of the permit program because both agencies perform separate engineering evaluations to determine permit requirements for new and modified sources. However, we found little evidence to support either positive or negative conclusions regarding this duplication.

According to DOH and TACB regional staff, the purpose of the dual inspection is to ensure that problems resulting from local conditions not apparent in Austin will be addressed in the permit process. However, TACB headquarters personnel indicated that very few of the permit applications are substantively altered as a result of input from the Houston Department of Health. Also, DOH receives very little feedback from TACB headquarters on the documents issued by the Department of Health.

One alternative for improving administrative efficiency of the permit program suggested by DOH staff is to divide responsibility for portions of the permit program between the two agencies with no overlap. For example, DOH could make many of the preliminary engineering calculations

as well as provide comments concerning any unusual local conditions to the TACB. The TACB could then rely on the preliminary information submitted from the DOH and determine the air quality impact of the proposed facility, using air quality modelling if necessary.

2. THE SURVEILLANCE PROGRAM

Although Houston has an excellent permit program, source noncompliance is inevitable, and the ability of the agency to detect and document violations can be critical to the success of its regulatory effort. The Houston Department of Health surveillance program is made up of four elements:

- General Surveillance involves the 24-hour daily surveillance of major sources by automobile, boat, and helicopter.
- Annual SIP Inspections involves the investigation of major sources on an annual basis to determine compliance.
- Complaint Investigation involves the investigation of complaints received by the Houston Department of Health.
- Self Reporting for Upsets and Maintenance involves the investigation of sources notifying the Department of Health because of upsets and maintenance violations. The purpose of these violations is to ensure that emissions are minimized during these periods.

Generally, we found that these elements were effective in detecting violations and that the constancy of surveillance creates an agency presence which encourages source compliance. However, we also found the agency weaker at documenting violations after detection, and in surveillance activities related to pollutants which were not visible such as sulfur oxides and hydrocarbons.

(1) Visible Emissions Detection and Complaint Investigations Are Effective

As a result of its 24-hour surveillance program and the division of jurisdiction into four surveillance areas, the city agency is especially effective in the

detection of visible emissions and the investigation of complaints. The division of Houston into four areas allows DOH inspectors to become familiar with the types of industry and processes within their particular districts. Also, sources develop a working relationship with the personnel assigned to that district and become aware that surveillance is done on a routine basis. Both agency and source personnel believe that continuing compliance is promoted primarily by the constancy of surveillance rather than the sources fear that detection of violation will result in sanctions.

Our study of source compliance confirms our preliminary evaluation that the surveillance program was effective in the detection of visible emissions and complaint investigations. Based on our evaluation of 20 sources, we found that the Department of Health detected about 75 percent of all serious violations. In addition, in about 70 percent of the cases, citizen complaints were a factor in alerting the agency to source noncompliance. The the program as a whole, complaint investigations accounted for over one third of all surveillance reports.

(2) Documentation of Violations for Litigation Purposes Is Limited

Although the DOH is effective in the detection of source noncompliance, the documentation for litigation purposes is sometimes weak. Of the approximately 1800 notices of violation issued in 1977, 97.5 percent were issued for problems which are not measurable such as nuisance, outdoor burning, and excessive visible emissions. Notices of violation based on opacity, stack test, or property line tests which can be documented in court average 2.5 percent of the total.

The use of stack tests, opacity, and property line ambient measurements to quantify violations should be increased. This increase would not only improve the violation documentation for litigation, but also shift the program's emphasis from traditionally local program concerns such as nuisance and complaints to cases related to such air quality problems as stack or fugitive emissions.

(3) Surveillance Activity Related to Sulfur Dioxide and Hydrocarbon Emissions Appears Limited

Surveillance activity relating to sulfur dioxide and hydrocarbon emissions is very limited compared to surveillance relating to particulate matter. There are several possible reasons for this. First, Houston does not have a serious sulfur oxide problem because many of the industrial processes are gas-fired. Secondly, much of the Houston surveillance program is structured to detect emissions by sight rather than by measurement. Thus, invisible emissions may go undetected. Finally, concerning hydrocarbons, the hydrocarbon regulations are equipment standards with many engineering parameters mandated to prevent the escape of volatile hydrocarbons into the atmosphere. Additional engineering expertise may be needed to verify many of the technical parameters necessary to determine compliance.

One way to increase surveillance of both sulfur oxides and hydrocarbons is greater use of property line ambient sampling measurements. In the case of hydrocarbons, no ambient property line regulation exists in Texas, although the state has considered developing such a standard. Unfortunately, the equipment to sample hydrocarbons is less developed and less reliable than the equipment used to measure sulfur oxides or particulate matter. Also, at the present time, it is not clear what role hydrocarbon emissions play in contributing to the oxident problem, especially in the Houston area. Until those hydrocarbon issues are resolved, the TACB is likely to continue to enforce the present regulations, rather than adopt new regulatory requirements.

3. THE ENFORCEMENT PROGRAM

Our evaluation of the enforcement program focuses on the postcompliance efforts of the Houston Department of Health. In our analysis of agency programs and source performance, information was also discovered which provided insights concerning state regulations and state precompliance enforcement efforts. This information is also presented.

The basic approach and philosophy of the Houston Department of Health emphasizes the promotion of voluntary compliance instead of legal enforcement. The enforcement process consists of citing the violation, negotiating a compliance plan with the source, and seeking civil or criminal sanctions as

a last resort. Generally, we found that the early efforts of the state were successful in causing sources to install pollution control equipment. We also found that while the Houston Department of Health program of seeking voluntary compliance may be effective in promoting compliance among sources which need little incentive to comply, it does not appear effective for more recalcitrant sources.

(1) The State Regulatory Requirements and the State Precompliance Enforcement Efforts Appear Successful

The state regulatory requirements which apply to existing stationary sources have proven to be effective tools for enforcement. The types of regulations which are used by Texas to regulate existing sources are particularly diverse. In regulating particulate matter, for example, emission limitations, opacity, equipment standards, process weight, work practice procedures, and ambient property line regulations are all used. Such diversity in the different kinds of regulations have provided several alternatives in monitoring, surveillance and enforcement. For example, the ambient property line regulation has proved successful in dealing with the problem of fugitive particulate matter and sulfur oxides. A violation of this regulation occurs when the net result of subtracting the downwind from the upwind ambient concentration measured at the property line exceeds the one-hour, three-hour, or five-hour standard. Enforcement is made easier because emissions do not need to be traced to a particular stack or point on the property to prove a violation. Also, the property line ambient sampling equipment is much easier and cheaper to use than stack test devices.

In addition to effective regulatory requirements, state enforcement actions in the early seventies were a major factor in promoting compliance according to our source investigations. Of the 20 sources investigated in Task II, 7 sources installed control equipment in response to lawsuits brought by the Texas Air Control Board.

(2) The Department of Health Enforcement Program Is Ineffective in Using Sanctions To Promote Continuing Compliance

Although the enforcement approach used by DOH of seeking voluntary compliance may be effective in promoting

compliance among sources which need little incentive to comply, it does not appear effective for more recalcitrant sources. These sources may require the threat of a strong enforcement program with sanctions aimed at deterring future violations.

Our evidence shows few instances where the DOH has taken administrative action beyond holding informal meetings and issuing notices of violation (NOV). For example, of the 1,800 notices of violation issued by the DOH in 1977, only 8 were followed by administrative conferences. Although this low number of administrative conferences could indicate that almost all the sources in the Houston area which receive an NOV require no further agency action to achieve compliance, our data from the source investigations indicate that further agency action is usually needed. Of 20 sources investigated in Task II, 9 received NOV's from the DOH and of these, 7 were estimated to be out of compliance from 5 to 20 percent of the time.[1] None of these sources were requested to participate in an administrative conference to develop a compliance plan. It is not clear from our data whether additional enforcement actions would promote compliance in all these instances. In some cases, violations are due to process and control equipment upsets which cannot always be controlled by the source. However, in other instances it appears that the source is taking little if any actions to minimize upset problems. For example, two companies investigated in Task II reported upsets between 100 and 200 times in one year. Those companies apparently felt that as long as the upset condition was reported to the agency, no enforcement action would be taken. Other than the issuance of a notice of violation by the DOH, their assumption appears correct.

Many times enforcement actions such as holding administrative conferences or seeking criminal and civil fines do not promote compliance. Of the 8 sources which attended an administrative conference in 1978, all 8 were later referred for legal action. This indicates a failure of good faith efforts to comply with commitments made by the sources during the administrative conferences. In addition, cases referred to the City Legal Department for civil or criminal action rarely result in significant penalties. In many instances, once a case is referred,

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1 Private communication with Dr. Herbert J. Belknap, principal investigator, PEDCo Environmental Inc.

no action is taken for periods of time lasting as long as several years. Although the reason given for this delay is poor case preparation by the DOH and lack of manpower by the Houston Legal Department, little or no communication is made between the two agencies to resolve the delay or expedite the process for specific cases. Of the 24 cases referred to the City Attorney's Office in 1977, 8 were indefinitely delayed, 7 were dismissed in court, 3 sources abated the problem, and 6 sources received fines. Of the 6 sources which received fines, 1 was $2,000, and 5 were from $200-500. This compares to a legal maximum of $10,000 per day of violation.

Although we cannot demonstrate that a more aggressive enforcement strategy would yield better compliance, we can assume that the threat of sanctions can provide an effective incentive for recalcitrant sources to reduce emissions. The enforcement process can be strengthened by the use of more administrative conferences, more civil and criminal actions, and more enforcement actions against sources with operation and maintenance problems which result in chronic violations. More conferences should be held with those sources that require additional agency action to come into compliance beyond receiving a notice of violation. The conference can then be used to require a more formal commitment by the sources to take specific measures to achieve compliance. It should be noted during the conference that any delay in meeting commitments will result in legal action. If the agency believes that a source will not come into compliance as a result of a conference, then the agency should refer that source directly to the City Attorney's Office for civil or criminal actions.

Once it is determined that additional sanctions beyond the administrative conference are necessary, legal action should be as swift as possible. To expedite the litigation process, better communication between the Department of Health and the City Legal Department concerning the status of cases and required additional documentation are needed. Also, should cases be delayed indefinitely, assistance should be sought from the state. The state could then prosecute such cases through the State Attorney General's Office. Finally, sanctions sought should be high enough to deter other sources from violating the regulations.

Enforcement actions should be brought against sources with operation and maintenance problems resulting in

chronic violation. Such action could be imposed by agreement during the administrative conference or by a court if the source does not agree. The problem source might be required to seek engineering assistance to correct design deficiencies, purchase new equipment if present control or process equipment is old and subject to upsets, or partially close down the facility during upset episodes.

Although these suggestions are presented as possible options to improve the enforcement program, the cost-effectiveness of such a policy is not clear. Although legal enforcement can be expensive in both budgetary and political terms, a stronger deterrent to emissions violations hopefully would yield better compliance.

IV. MODIFICATIONS TO CURRENT PROGRAMS

In order to improve its effectiveness in promoting stationary source emissions reductions, the Houston Department of Health could either strengthen its existing direct regulation programs or adopt supplements and alternatives to regulation.

Since Chapter III already has addressed adjustments to the current programs, this chapter merely summarizes those recommended adjustments in Exhibit IV-1 and focuses on potential supplements and alternatives.

Our presentation of alternatives to current programs consists of the following. First, we briefly summarize major factors which need to be considered in designing and evaluating economic incentive programs. Second, we describe four possible economic incentive program categories and assess their potential applicability to Houston's situation.

1. EVALUATION FACTORS

The actual adoption of economic incentives must reflect an assessment of their likely effectiveness in promoting a reduction in excess emissions and an identification of the statutory institutional changes needed. Key factors to be considered in this assessment include compatibility of economic incentive program with the technical and administrative requirements for existing programs; the level of control technology available and impact on technology forcing; monitoring, and enforcement requirements. These factors are reflected in our estimate of the likelihood of economic incentives contributing to a further reduction of excess emissions in Houston.

2. ECONOMIC INCENTIVE PROGRAMS

The following discussion of four categories of economic incentives distinguishes between programs most helpful in fostering initial compliance and those promoting continuing compliance. It also assesses the extent to which each incentive would be appropriate to Houston's situation.

EXHIBIT IV-1
Summary of DOH Program Problems
and BAH Recommendations

PROGRAM	PROBLEM	RECOMMENDATION
Permit Program	. Duplication of administrative review between state and city	. Divide responsibility for portions of program between state and city with no overlap
Surveillance Program	. Regulations too often based on subjective nuisance and excessive visible emissions	. Increase use of stack tests, opacity, and property line ambient measurements to document violations.
	. Surveillance of sulfur oxides and hydrocarbons is limited	. Increase surveillance of sulfur oxides and hydrocarbons by greater use of property line ambient samples
Enforcement	. Ineffective use of sanctions to promote continuing compliance	. Increase use of administrative conference . Increase number of civil and criminal cases . Increase dollar amount of sanctions . Initiate enforcement actions against companies with O&M problems causing chronic violations

(1) Reducing Financial Burden

The alternatives in this category primarily are useful in promoting initial compliance as they relieve the financial burden of installing costly pollution control equipment. They include:

- Tax credits for industries achieving compliance
- Federal/state/local cost-sharing funds for abatement equipment
- Low interest loans for industries purchasing and installing abatement equipment.

Our investigation of source performance produced no evidence that excess emissions problems resulted from lack of control equipment. In fact, as stated in Chapter III, the state was very successful in promoting initial compliance by aggressive legal action against sources that did not install control equipment. As a result, additional financial incentives do not appear to be necessary.

Currently, private sector sources receive no direct financial assistance from government. Even if the capital and O&M costs are not burdensome and are not a significant contributing factor to noncompliance, industry is likely to welcome a revenue sharing plan. However, in the absence of any clear evidence that industry requires financing assistance, such a measure is likely to be politically infeasible and is unlikely to result in emissions reductions.

(2) Providing Investment Incentives

Several pricing mechanisms are available to give incentives to polluters to install control equipment (initial compliance) and operate and maintain it (continuing compliance) properly. Major alternatives in this category are:

- Taxes on polluting industries
- Surcharges on pollution-intensive goods
- Emission charges
- Noncompliance fees
- Delayed compliance fees.

Under the first mechanism, the tax could be imposed either on production materials or on the finished product. In the former case, the tax rate could be varied according to the difficulty of eliminating pollutants discharged and in the latter case could be a fixed tax on each output. The objective is to make it economical for the source to use less polluting process materials or to adopt end-of-the-pipe controls.

The second mechanism essentially places the cost burden on the consumer, putting a tax on products which have adverse environmental impacts. Presumably, the producer would be motivated to make his products less environmentally harmful to avoid the adverse impacts on product competitiveness resulting from the surcharge.

Emission charges, the third alternative, consist of making the polluter pay a sum proportional to the amount of pollution discharged. While in theory the charge should be linked to the damage function, that is, the exact amount of environmental damage caused, in practice such charges would have to be linked to emission standards, due to the difficulties involved in defining and ascertaining damage. Thus, charges become an economic incentive for the polluter to achieve and maintain a standard by setting the charge at a level designed to result in a desired level of treatment.

Both noncompliance and delayed compliance fees are penalties keyed to amount of pollution and/or length of violation. Thus the noncompliance fee could escalate according to ranges of excess emissions and the delayed compliance fee could escalate according to the length of time the violation continues after the expiration date of a negotiated compliance schedule.

All five alternatives are vastly more complicated than the present system, each requiring fees or charges based on environmental damage, the cost of compliance, or the cost of noncompliance. In addition, all five alternatives are likely to face problems similar to those found for current DOH programs. Specifically, establishment of a taxation or emission charge strategy has many of the same requirements as present programs, such as monitoring source emissions and/or product output levels. In addition, a strong enforcement program would be necessary to impose the various fines and taxes suggested. As a result, in order to implement these alternative programs in an effective manner, the city of Houston would first have to adopt the adjustments recommended in Chapter III to remedy existing weaknesses.

(3) Instituting Hybrid Permit Systems

The category of alternatives is based on the idea that emission standards specify the "pollution rights" available to each source. Three possible mechanisms are:

- Marketable discharge permits
- Differential pricing of permits
- Sureties.

Each of these contributes differently to the fostering of Initial and continuing compliance.

Marketable discharge permits are permits which would be negotiable and sold at prices determined by the demand for emissions rights. Under the system, sources reluctant to shoulder the capital and O&M costs of installing equipment could purchase pollution rights from sources willing to invest in a level of control beyond the requirements. The public sector, that is the regulatory agency, could abate pollution by purchasing permits, thus reducing the total amount of allowable emissions. This mechanism would promote both initial and continuing compliance.

Differential pricing of permits also can be used to promote both initial and continuing compliance. Regulatory agencies would continue to issue permits but would charge a fee based on the level of controlled emissions. Sources which exceed the emissions for which they paid would face an additional charge. Presumably, if these fees are set sufficiently high, sources would find it economical not only to install control devices but also to operate and maintain them properly.

A surety system, the third alternative under this category, would operate in much the same manner as a performance bond. The source would place a set sum in escrow. The source would forfeit a portion of the sum for a certain level, frequency, or duration of excess emissions whereas it would receive a rebate varying according to the degree emissions were reduced below the standards. By requiring sources to post a new surety along with each permit renewal, this mechanism can promote continuing compliance and may also be technology forcing.

Adoption of one or more of the hybrid permit strategies in Houston would be useful in shifting the focus from initial to continuing compliance. However, like the pricing alternatives, to implement the hybrid permit

programs effectively, the agency first would have to adopt many of the adjustments recommended in Chapter III. The variable priced permits and surety programs would require an improvement in the inspection skills of agency personnel. Also, in the case of marketable permits, the agency would have to develop a new administrative capability to track the transfer of pollution rights. Without that tracking capability, the agency would be unable to determine whether sources are producing emissions in excess of the rights they have purchased. Finally, the success of market permit and surety programs requires a strong enforcement posture currently absent.

(4) Encouraging Purchase of Goods From Complying Firms

The final category of nonregulatory approaches to control of all emissions involves enhancing the product and general economic condition of sources which curtail their pollutants. One example of this approach is for government agencies to implement their procurement processes in a manner beneficial to nonpolluters. Thus, a government agency could purchase paper only from those mills which either meet emission standards or control beyond the standards. A second possibility would be for the state to create a fund to subsidize advertising for sources in compliance with the standards.

These two alternatives have several problems which might hinder their successful implementation. The encouragement of the purchase of goods by government agencies in a manner beneficial to nonpolluters is done at the national level with unsuccessful results. EPA can blacklist firms from Federal Government procurement if that firm is in violation of the Clean Air Act. Among the problems with this procedure are the necessity for an adjudicatory hearing to provide due process of law. This hearing itself would be at least as time-consuming as the present litigation process. The possibility of subsidizing the advertising of sources in compliance is probably politically infeasible. Most legislatures tend to be reluctant to impose additional costs on their constituents, particularly if the benefits are not clearly documented.

The final disadvantage of these strategies is that they fail to address the weaknesses of the current programs in Houston. Like those programs, programs in this fourth category of nonregulatory approach still require setting source specific requirements and monitoring and

inspecting sources to determine their compliance with those requirements. Correction of existing program news would have to precede adoption of either of the two strategies in this category.

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In order to document convincingly the appropriateness of nonregulatory alternatives in Houston, additional investigation is necessary. This investigation should poll various interested parties to determine more thoroughly the institutional and political feasibility of various incentives. Also, it should define a strategy for adopting those incentives which are likely to promote continuing compliance.

APPENDIX A
Summary of Source Costs

Source	Industrial Category	Uncontrolled Emissions ton/yr	Emission Reduction ton/yr	Capital Cost $(000)	Capital Cost Year	Annual Maint. $(000)	Capital Cost $/ton/yr
21	2	17,280	17,082	3,600	1973	930	210
22	2	N/A	N/A	N/A	N/A	N/A	N/A
23	4	1,728	1,318	200	1976	N/A	152
24	4	1,296	968	720	1970	50	744
25	4	993	960	2,300	1975	50	2,396
26	4	2,160	1,560	200	1963	30	128
27	4	1,980	1,881	7,000	1978	644	3,721
28	5	5,400	5,220	3,645	1971	243	698
29	5	720	486	500	1962	260	1,028
30	6	500*	486	75	1975	50	154
31	6	400*	370*	42	1973	N/A	114
32	7	648	626	N/A	N/A	N/A	N/A
33	8	2,496	2,372	600	1973	N/A	253
34	8	21,600	20,045	15,000	1975	1,860	748
35	11	8,640	8,010	2,500	1977	567	312
36	13	2,790	2,744	750	1970-6	250	273
37	13	3,000*	2,950*	1,400	1971-5	200	475
38	14	5,040*	5,000	900	1974	N/A	180
39	14	518	474	80	1970	27	168
40	16	N/A	N/A	N/A	N/A	N/A	N/A

N/A = Data not available.

*Estimated

APPENDIX B
Estimation of DOH Air Pollution
Control Program Output Costs

	1976	1977	1978
Enforcement			
1. Total Dollars	444,787	382,881	441,726
2. Total Output—Complaints and NOVs	3,134	3,810	3,806
3. Dollars/Output—Complaints and NOVs	141	100	116
Permits			
1. Total Dollars	66,862	58,769	108,053
2. Total Output—Permits	111	140	129
3. Dollars/Output—Permits	602	419	837
Monitoring			
1. Total Dollars	360,210	150,927	391,409
2. Total Output—Source and Facility Investigations	1,660	4,941	4,016
3. Dollar/Output—Investigations	216	30	97

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1 At the client's request we have divided the outputs for enforcement, permits, and monitoring into the total dollar amount budgeted for each program as taken from the 1976, 1977, and 1978 Grant Applications. Because the activities and expenses which are classified as enforcement, permits, or monitoring, for purposes of the grant applications changed significantly from 1976 to 1978, these figures should not be used as a measure of cost effectiveness.